

Pamunkey River and Tributaries TMDL First Public Meeting

February 20 & 21, 2013



NATURAL RESOURCE SOLUTIONS
THROUGH *Science AND Engineering*

Why Are We Here?

To discuss bacteria TMDLs for the Pamunkey River and Tributaries watershed

Total Maximum Daily Load is how much pollutant can enter the stream and have the stream meet the water quality standards



What is a TMDL ?

Total Maximum Daily Load

A TMDL is the maximum amount of a pollutant a water body can receive and still meet water quality standards. AKA "Pollution Diet"

$$\text{TMDL} = \text{Sum of WLA} + \text{Sum of LA} + \text{MOS}$$

Where:

TMDL	=	Total Maximum Daily Load
WLA	=	Waste Load Allocation (point sources)
LA	=	Load Allocation (nonpoint sources)
MOS	=	Margin of Safety

Recreational Use Impairment: Fecal Coliform, *E. coli* and Enterococci Bacteria

Escherichia coli:

- Subset of fecal coliform bacteria
- Correlate better with swimming associated illness in freshwater

Enterococci:

- Subset of fecal streptococcus bacteria
- Indicator used for determining recreational risks in salt or transitional waters

Indicator	Geometric Mean (CFU/100 ml)	Instantaneous Max (Single Sample)
E. Coli (Freshwater)	126	235
Enterococci (Transitional and Saltwater)	35	104

- *Geometric Means calculated using data collected during any calendar month with a minimum of four weekly samples.*
- *If insufficient data to calculate a monthly geometric mean, no more than 10% of the total samples in the assessment period should exceed 235 cfu/100 ml of E. coli in freshwater, and 104 cfu/100 ml of enterococci in transitional and saltwater.*

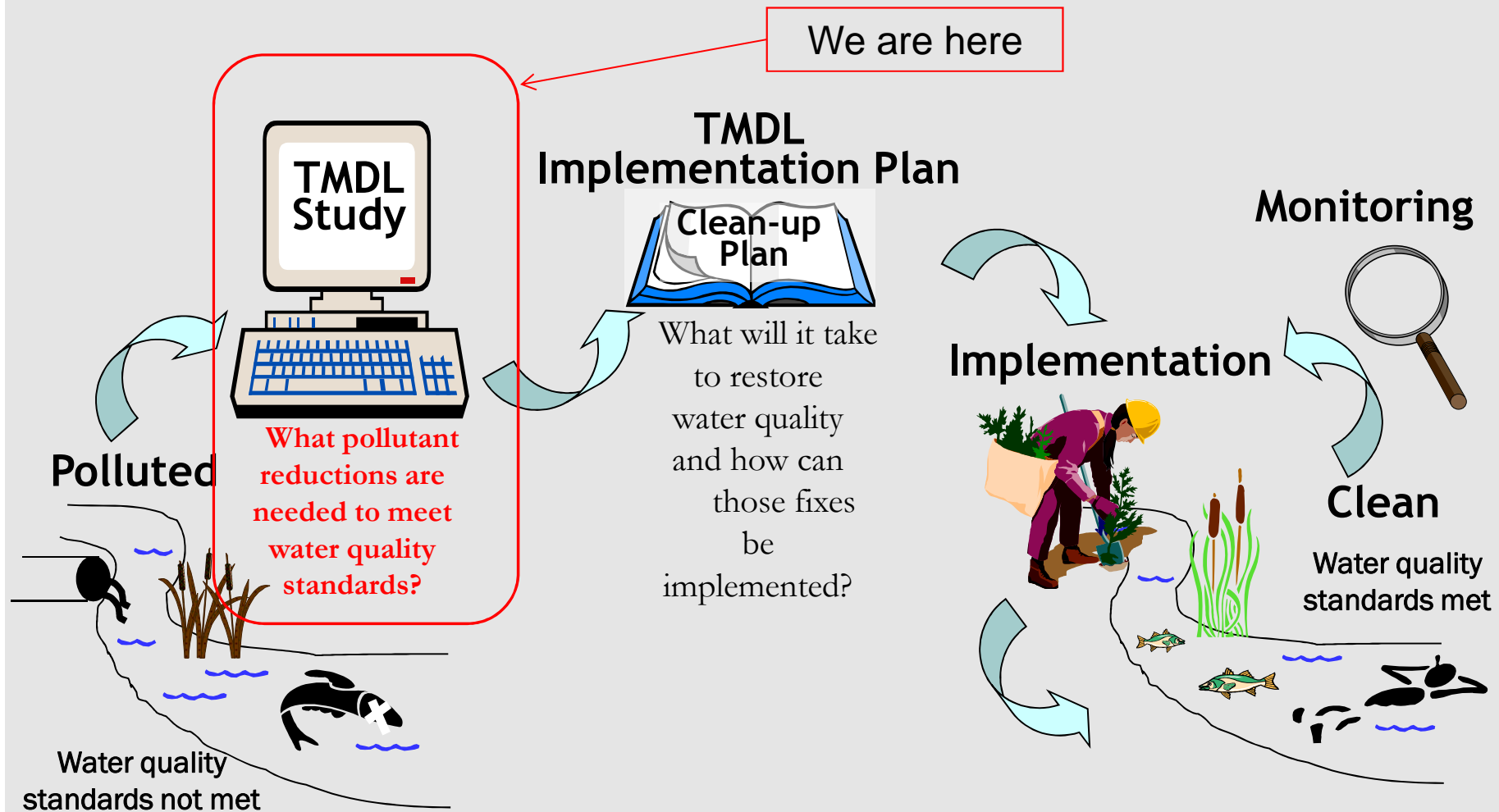
Designated Uses

- **Recreational**
- Public Water Supply
- Wildlife
- Fish Consumption
- Shellfish
- Aquatic Life



The attainment of the recreational use is evaluated by testing for the presence of E. coli bacteria in freshwater systems and enterococci bacteria in transitional and salt waters.

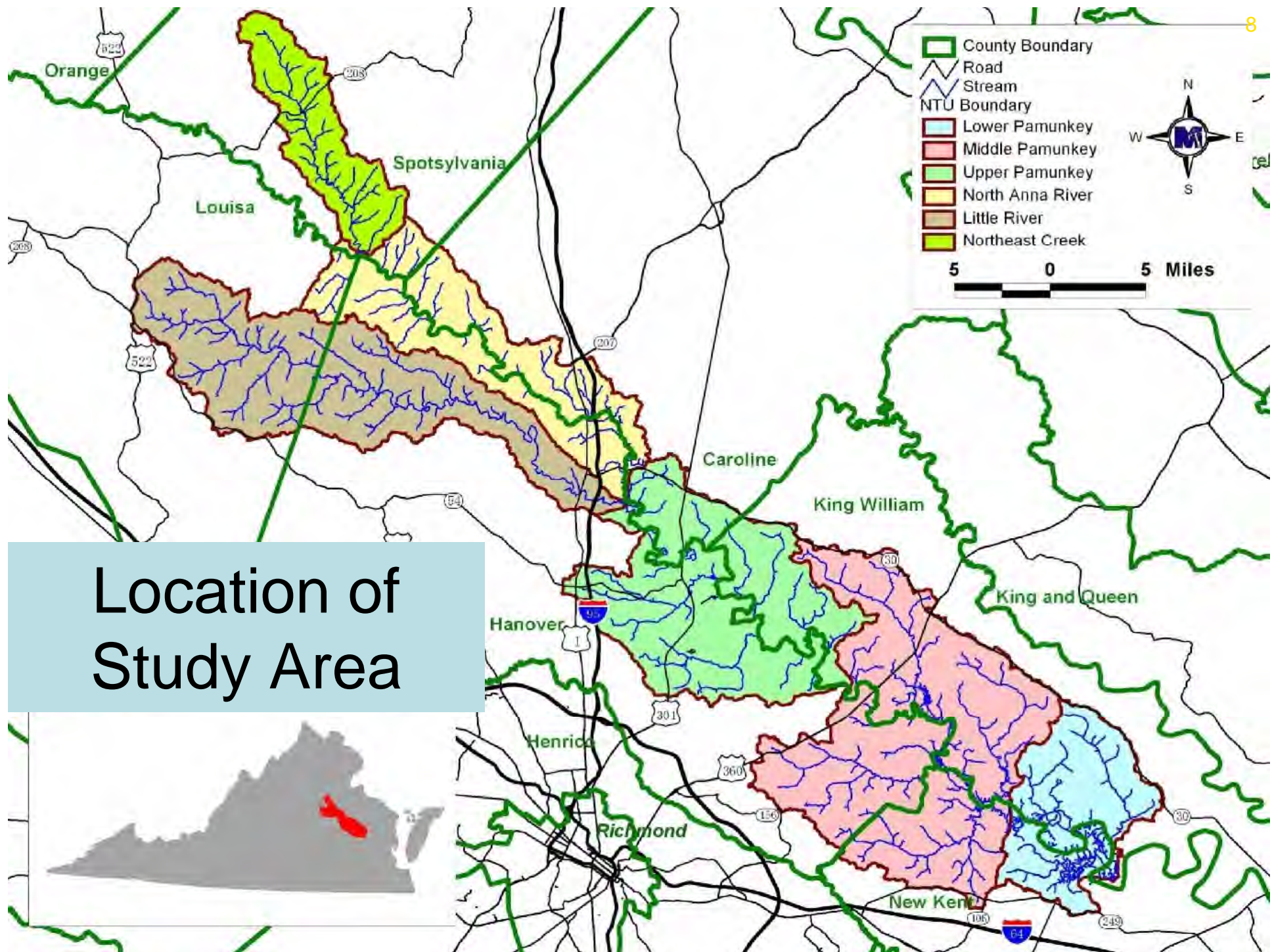
Overview of TMDL Process



The Pollutants We Are Dealing With Here

- Excessive Bacteria





E.coli Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	Draft 2012 River Miles (Sq Miles)	Draft 2012 Listing Violation %	Impairment Location Description
Beaverdam Creek VAP-F11R_BDC01A12	E. coli	2012	8.47	44	From the headwaters to its confluence with the Little River.
Crump Creek VAP-F12R_CRU01A02	E. coli	2008	10.08	15 25 17	From its headwaters to its mouth.
Crump Creek X-Trib. VAP-F12R_XJC01A12	E. coli	2012	1.79	42	From the headwaters to its confluence with Crump Creek.
Harrison Creek VAP-F14R_HSN01A00	E. coli	2008	2.80	37 38 17	Upstream of a pond at Elsing Green downstream to the nearest tributary.
Harrison Creek VAP-F14E_HSN01A12	E. coli	2012	(0.05)	33	Tidal portion of Harrison Creek at its mouth.
Harrison Creek X-Trib. VAP-F14R_XJD01A12	E. coli	2012	0.16	50	From its headwaters to its confluence with Harrison Creek.



Segments listed are new impairments only. Not included are the impairments with existing TMDL

E.coli Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	Draft 2012 River Miles (Sq Miles)	Draft 2012 Listing Violation %	Impairment Location Description
Jacks Creek & Tribs. VAP-F13R_JCK01A98	E. coli	2008	21.05	18	From its headwaters downstream to its confluence with the Pamunkey River.
Kersey Creek VAP-F12R_KER01A12	E. coli	2012	2.76	25	From its headwaters downstream to its confluence with Crump Creek.
Little River VAN-F10R_LTL01A02	E. coli	2006	4.01	23	From its confluence with Hawkins Creek downstream to its confluence with Locust Creek.
Little River VAP-F11R_LTL01B08	E. coli	2008	10.77	25	From its confluence with Locust Creek downstream to its confluence with Beaverdam Creek.
Mill Creek VAP-F09R_MLL01A12	E. coli	2012	4.39	54	From its headwaters downstream to its confluence with the North Anna River.
Northeast Creek VAN-F09R_NST01A08	E. Coli	2008	2.74	25	From its confluence with an unnamed tributary to Northeast Creek and continuing downstream until the confluence with the North Anna River



Segments listed are new impairments only. Not included are the impairments with existing TMDL

E.coli Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	Draft 2012 River Miles (Sq Miles)	Draft 2012 Listing Violation %	Impairment Location Description
Pamunkey River X-Trib. VAP-F13R_XDW01A08	E. coli	2012	5.51	25	From its headwaters downstream to its confluence with the Pamunkey River.
X-Trib of Pamunkey River X-Trib VAP-F13R_XDX01A04	E. coli	2012	3.85	25	From its headwaters downstream to its confluence with Pamunkey Tributary (XDW).
Pollard Creek VAP-F12R_PLD01A12	E. coli	2012	4.06	17	From its headwaters downstream to its confluence with Crump Creek.
Pamunkey River VAP-F12R_PMK01B08	E. coli	2008	12.26	16	From its headwaters downstream to its confluence with Mechumps Creek.



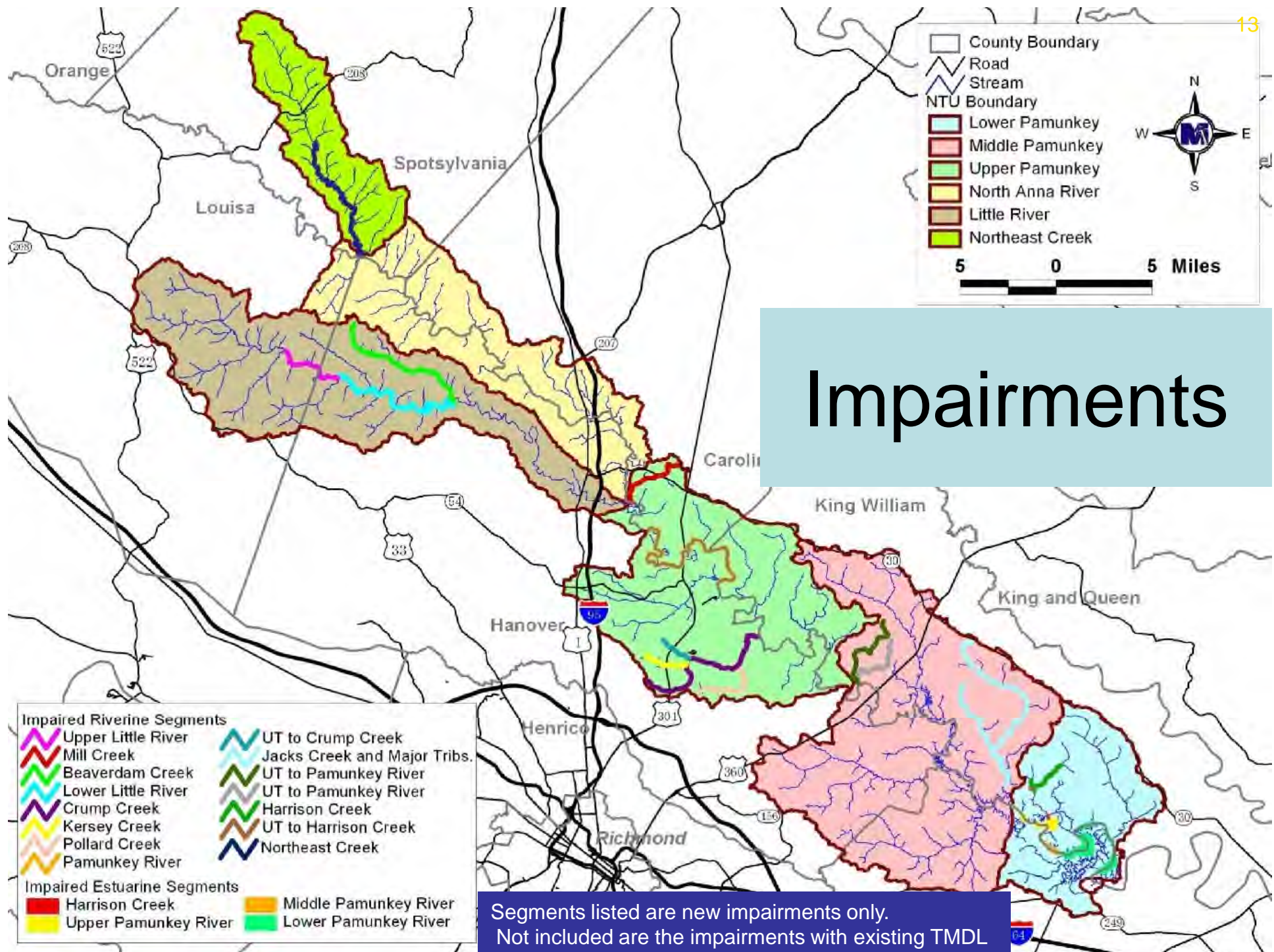
Segments listed are new impairments only. Not included are the impairments with existing TMDL

Enterococcus Impairments

Stream Name Impairment ID	Imp. Type	Initial Listing Year	2012 River Miles (Sq Miles)	2012 Listing Violation %	Impairment Location Description
Pamunkey River VAP-F14E_PMK02A00	Ent.	2010	(0.81)	13	From Macon Creek downstream to river mile 34.25.
Pamunkey River VAP-F14E_PMK03A00	Ent.	2010	(0.38)	13	A one mile radius around VADEQ monitoring station 8-PMK032.00.
Pamunkey River VAP-F14E_PMK04A00	Ent.	2010	(2.44)	13	One mile downstream of 8-PMK032.00 to the downstream extent of tidal freshwater segment at approximately river mile 23.6.



Segments listed are new impairments only. Not included are the impairments with existing TMDL



Watershed Size

Watershed	Acreage
Northeast Creek	27,014
North Anna River	53,124
Little River	75,790
Upper Pamunkey River	75,451
Middle Pamunkey River	104,320
Lower Pamunkey River	37,421

Land Use / Land Cover

Watershed (NTU Segment)	Forest	Cropland	Pasture	Wetland	Developed	Water	Barren	Commercial	LAX	Acreage
Northeast Creek	76.5	5.8	7.2	6.2	3.7	0.5	0.1	0.0	<0.0	27,014
North Anna River	76.1	5.1	7.2	4.3	5.1	1.1	0.3	0.8	<0.0	53,124
Little River	73.9	5.4	10.9	5.2	3.5	0.7	0.3	0.1	<0.0	75,790
Upper Pamunkey River	51.8	15.5	9.5	15.0	6.6	0.8	0.2	0.6	<0.0	75,451
Middle Pamunkey River	58.3	16.4	7.3	12.5	3.8	1.5	0.1	0.1	<0.0	104,320
Lower Pamunkey River	53.6	10.6	4.0	19.6	3.8	8.4	0.0	0.0	<0.0	37,421

Values in table are in percent

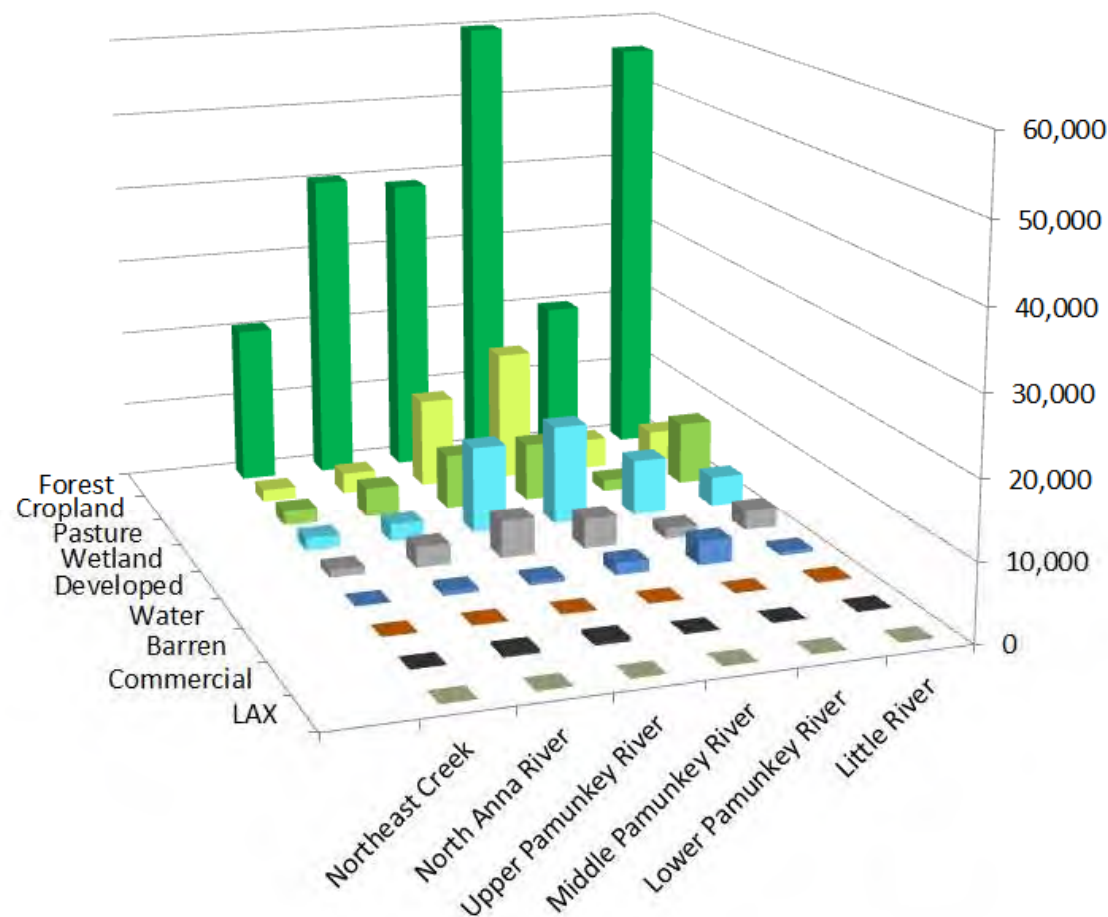
Source of data is the 2006 Multi-Resolution Land Cover (MRLC) Data

LAX is livestock access which represents areas of pasture adjacent to water bodies

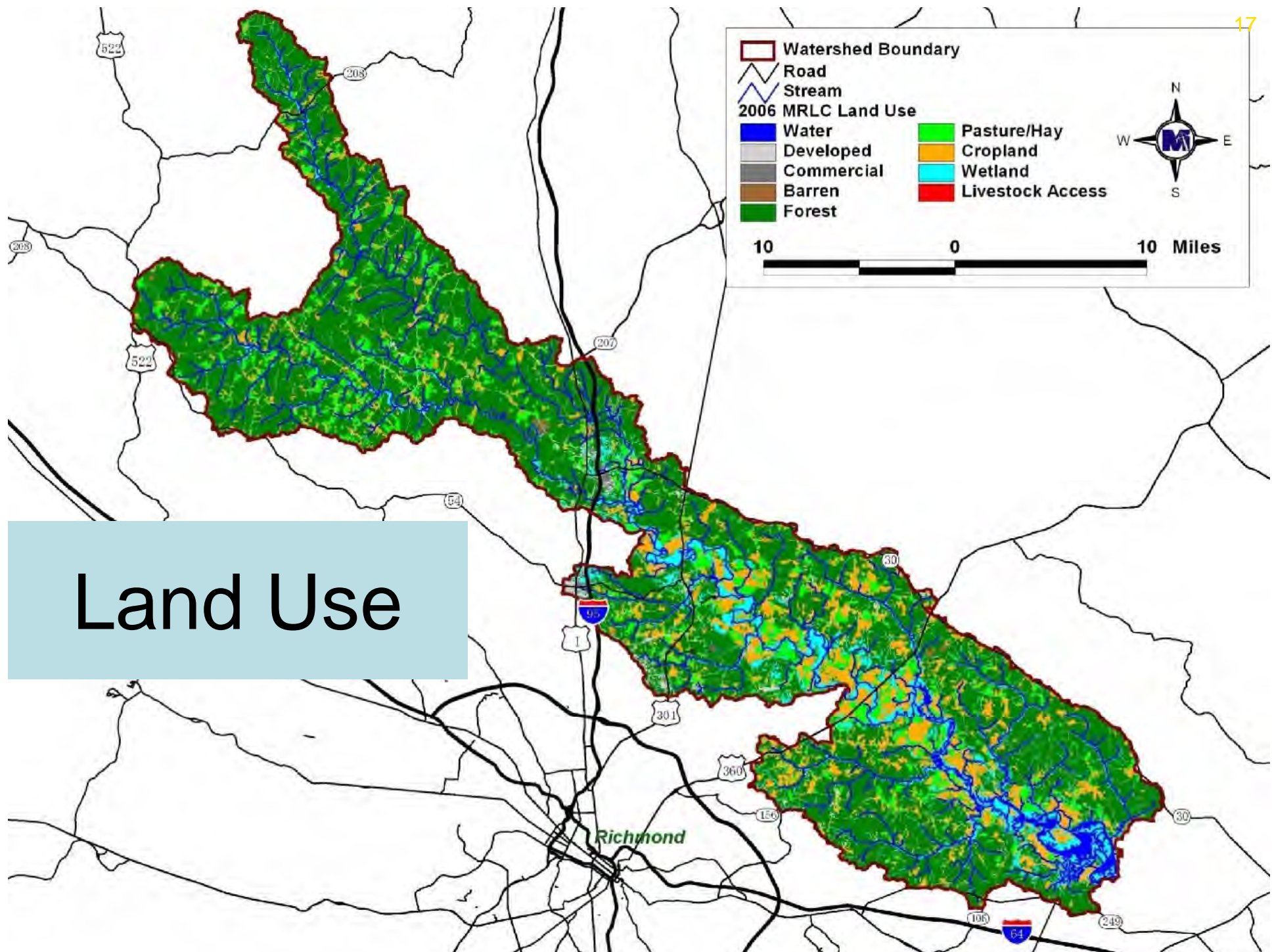


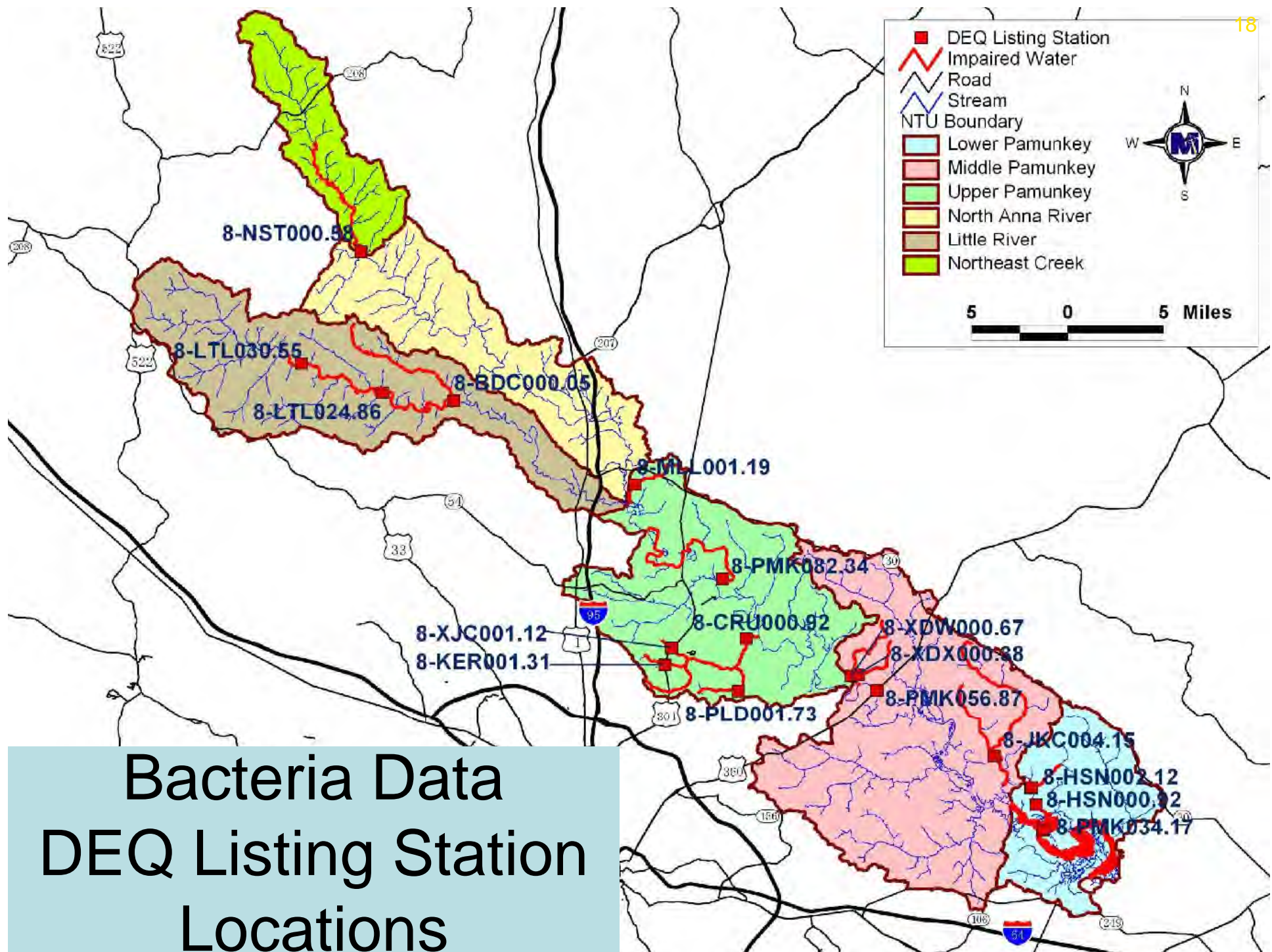
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Land Use- Acres



Source of data is the 2006 Multi-Resolution Land Cover (MRLC) Data





Bacteria Data DEQ Listing Station Locations

Water Quality Data Analysis

- *E.coli* -

Water Quality Data Analysis - *E.coli*

Statistics are in cfu/100mL . Stations are listed alphabetically

Creek	Listing Station	Date	Count	Min.	Max.	Mean	Median	St. Dev.	Violation ¹ %
Beaverdam Creek	8-BDC000.05	02/09 – 11/10	9	50	2,000	472	200	641.34	44.4
Crump Creek	8-CRU000.92	06/05 – 12/10	33	13	8,000	369	100	1,379.28	15.2
Harrison Creek	8-HSN000.92	04/10 – 03/11	12	100	800	225	100	226.13	25.0
Harrison Creek	8-HSN002.12	05/05 – 03/11	22	25	1,400	306	100	414.36	31.8
Jacks Creek and Tributaries	8-JKC004.15	07/03 – 10/11	32	20	1,200	165	100	233.43	21.9
Kersey Creek	8-KER001.31	01/10 – 12/10	12	25	550	177	110	191.68	25.0
Little River	8-LTL024.86	06/05 – 10/11	24	25	650	141	50	188.04	20.8
Little River	8-LTL030.55	03/03 – 7/12	46	25	2000	229	75	466.72	23.9
Mill Creek	8-MLL001.19	02/09 – 11/10	13	25	3,400	915	500	1,016.50	53.8
Northeast Creek	8-NST000.58	08/04 – 07/05	12	10	510	139	40	182.7297	25.0
Pollard Creek	8-PLD001.73	01/10 – 12/10	12	25	2,000	279	110	555.09	16.7
Pamunkey River ²	8-PMK034.17	07/04 – 10/11	86	25	900	105	75	140.88	10.5
Pamunkey River	8-PMK056.87	08/03 – 10/11	51	10	2,000	206	100	347.73	19.6
Pamunkey River	8-PMK082.34	12/05 – 10/11	35	14	650	103	50	126.67	14.3
Pamunkey River UT	8-XDW000.67	01/09 – 12/09	12	100	400	150	100	100	16.7
Pamunkey River UT	8-XDX000.38	01/09 – 12/09	12	100	500	217	200	146.68	25.0
Crump Creek UT	8-XJC001.12	01/10 – 12/10	12	25	2,000	356	220	539.7	41.7
Harrison Creek UT	8-XJD000.02	04/10 – 04/11	12	100	1,300	342	100	391.87	33.3

¹ Based on the current instantaneous *E. coli* standard of 235 cfu/100mL. Violations >10.5% = impaired.

² Pamunkey River estuarine impairment listed for *E.coli* data due to location.

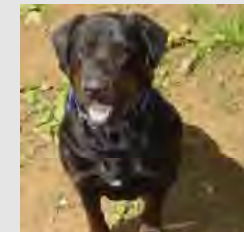


Only listing station (18) data is shown. If you would like all stations and data (total of 78 stations) within watershed please let us know and it can be shared via email

Bacteria Source Assessment

Source Assessment

- Permitted discharges
 - Wastewater treatment facilities
 - Other Permitted Discharges
- Human
 - Failed Septic Systems
 - Straight Pipes
 - Overflows
- Pets
- Livestock
- Wildlife



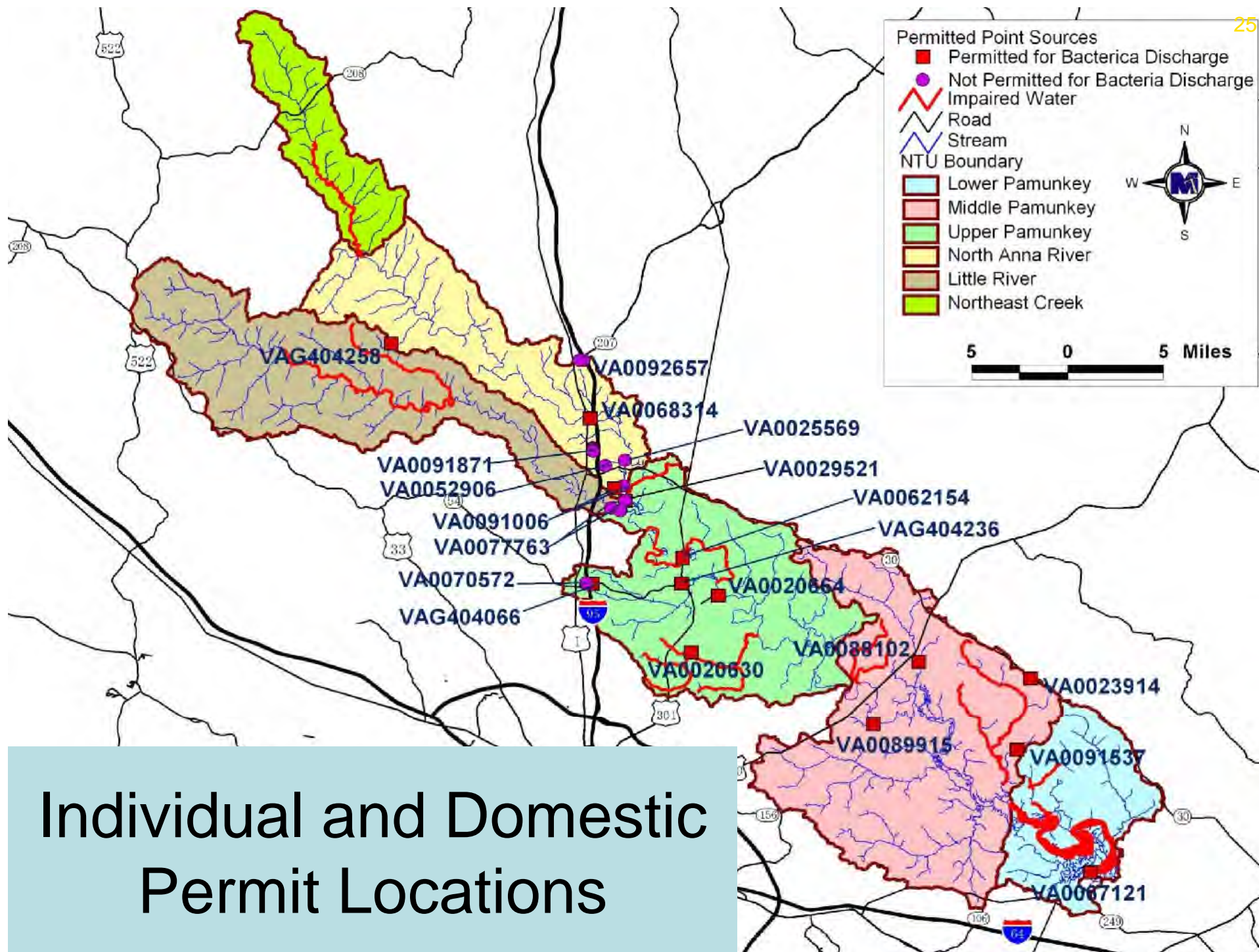
Permitted Discharges – Individual** (17)

Permit Number	Facility Name	WLA for Bacteria?	Receiving Stream
VA0020630	DJJ Barrett Juvenile Correctional Center	YES	Crump Creek
VA0020664	DJJ Hanover Juvenile Correctional Center	YES	Pamunkey River
VA0023914	Hamilton Holmes Wastewater Treatment Plant	YES	Acquinton Creek, UT
VA0025569	Hanover County Doswell WTP	NO	North Anna River
VA0029521	Hanover County Doswell WWTP	YES	North Anna River
VA0052906	Doswell Truck Stop	NO	North Anna River, UT
VA0062154	Hanover Courthouse WWTP	YES	Pamunkey R.
VA0067121	Cumberland Hospital for Children and Adolescents	YES	Pamunkey R.
VA0068314	Rhapsody Industrial Park - Purgo (CIRCAM, INC)	YES	North Anna R. UT
VA0070572	TravelCenters of America - Ashland Travel Center	NO	Mechumps Cr. UT
VA0077763	Bear Island Paper Company	NO	Little River, UT
VA0088102	HRSD King William County Sewage Treatment Plant	YES	Moncuin Creek
VA0089915	Hanover County Totopotomoy WWTP	YES	Pamunkey River
VA0091006	Kings Dominion	NO	North Anna, UT
VA0091537	Mount Olive Wastewater Treatment Facility	YES	Mallory Creek
VA0092657	Flying J Travel Plaza 749	NO	North Anna River, UT
VA0091871	Specialty Coatings LLC	NO	North Anna River, UT

**Includes permits which may be stormwater only

Permitted Discharges – Domestic Single Family Homes (3)

Permit Number	WLA for Bacteria?	County	Receiving Stream
VAG404066	YES	Hanover	Mechumps Creek UT
VAG404236	YES	Hanover	UT Mechumps Creek
VAG404258	YES	Hanover	UT Beaverdam Creek



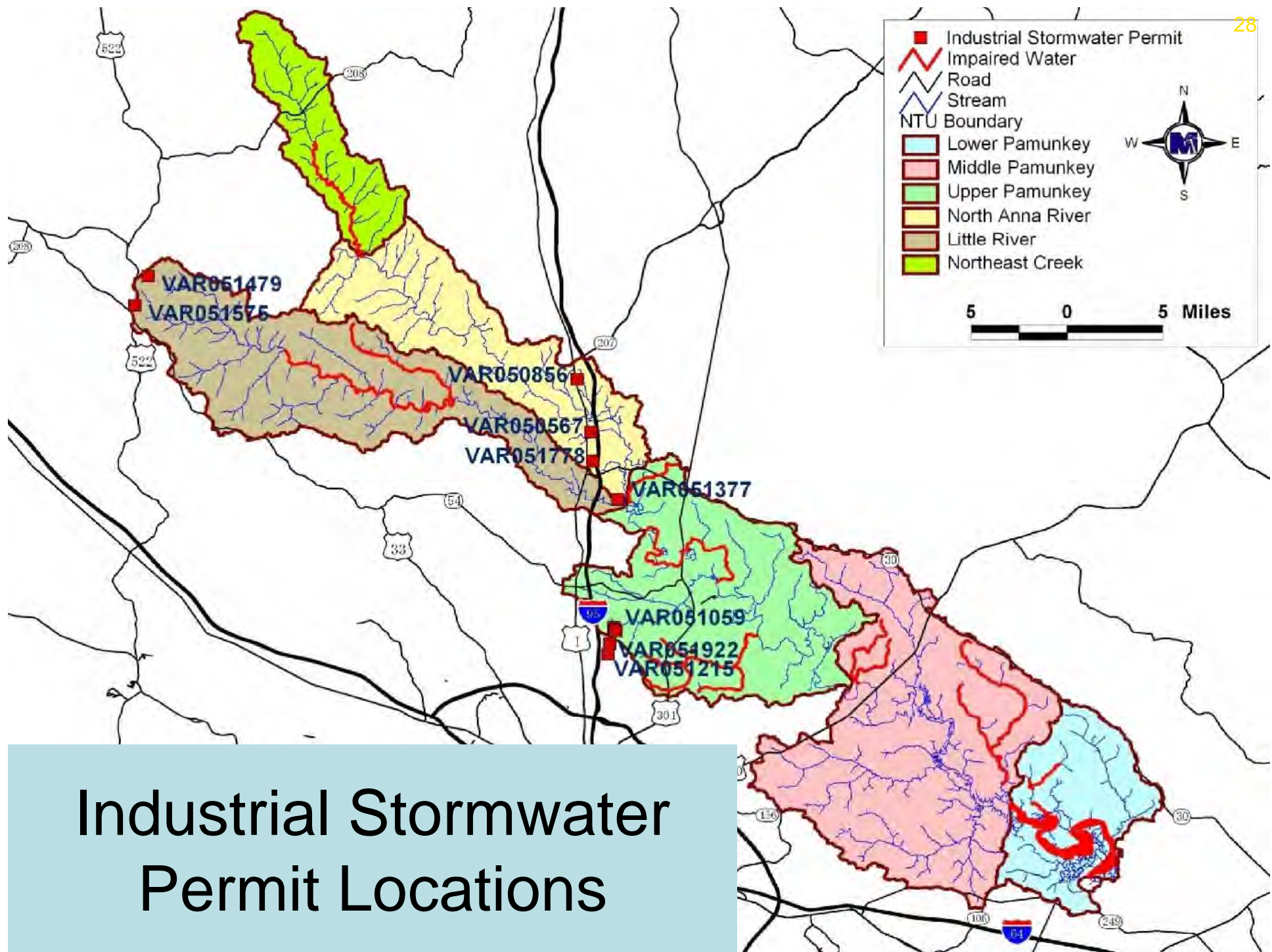
Individual and Domestic Permit Locations

Permitted Discharges – MS4 (3)

Permit Number	Permittee	Type	WLA for Bacteria?
VAR040012	Hanover County	II	Yes
VAR040011	Town of Ashland	II	Yes
VAR040115	VDOT	II	Yes

Permitted Discharges – Industrial Stormwater Permits

Permit Number	Facility Name	WLA for Bacteria?	Receiving Stream
VAR050567	Doswell Woodyard	No	Bull Run, UT
VAR051922	Phoenix Recycling	No	Totopotomoy Creek
VAR051575	Inside Auto Parts Incorporated	No	Little River
VAR051377	Hanover County Doswell WWTP	No	Little River
VAR051215	Hanover County Airport	No	Totopotomoy Creek
VAR051778	Bakery Feeds	No	North Anna River, UT
VAR051059	Ashcake Road Landfill, Inc.	No	Campbell Creek, UT
VAR051479	Louisa County Sanitary Landfill	No	Little River
VAR050856	JH Knighton Lumber Company Incorporated	No	North Anna River, UT



Industrial Stormwater Permit Locations

Human Sources

Population, housing units, and onsite treatment system based on U.S. Census

- **Septic Systems**
 - Failure to soil surface throughout year or during wet season only
 - Lateral movement continuously to stream
- **Straight Pipes**
 - Direct continuous input into stream
- “Other” category is broken down into Privies/Outhouses (90%) and straight pipes (10%)

Human Source Summary

Watershed Area (NTU segment)	Population	Housing Units on Sewer Systems	Housing Units on Septic Systems	Housing Units on Privies / Outhouses	Housing Units on Straight Pipes	Number of Failing Septic Systems
Northeast Creek	2,813	7	1,004	33	4	33
North Anna River	4,794	100	1,746	96	11	56
Little River	6,723	23	2,598	147	16	69
Upper Pamunkey River	16,018	2,278	3,657	180	20	113
Middle Pamunkey River	13,081	354	4,779	82	9	157
Lower Pamunkey River	1,317	3	511	17	2	11

Pet Sources

- Population/household based on literature values, veterinarians, and animal control
- Translated to housing units based on U.S. Census
 - 0.53 dog per housing unit
 - 0.6 cat per housing unit
- Land-applied

Pet Source Summary

Watershed Area (NTU Segment)	Dogs	Cats
Northeast Creek	559	626
North Anna River	1,043	1,168
Little River	1,487	1,665
Upper Pamunkey River	3,276	3,669
Middle Pamunkey River	2,790	3,124
Lower Pamunkey River	285	319

Livestock Sources

- Population
 - Virginia Agricultural Statistics
 - Consultation with SWCD, NRCS, VADCR, and VCE
 - Watershed visits
- Distribution of waste
 - Pastured
 - Confined, waste collected, spread
 - Direct deposition to the stream
- Seasonal varying applications

Livestock Source Summary

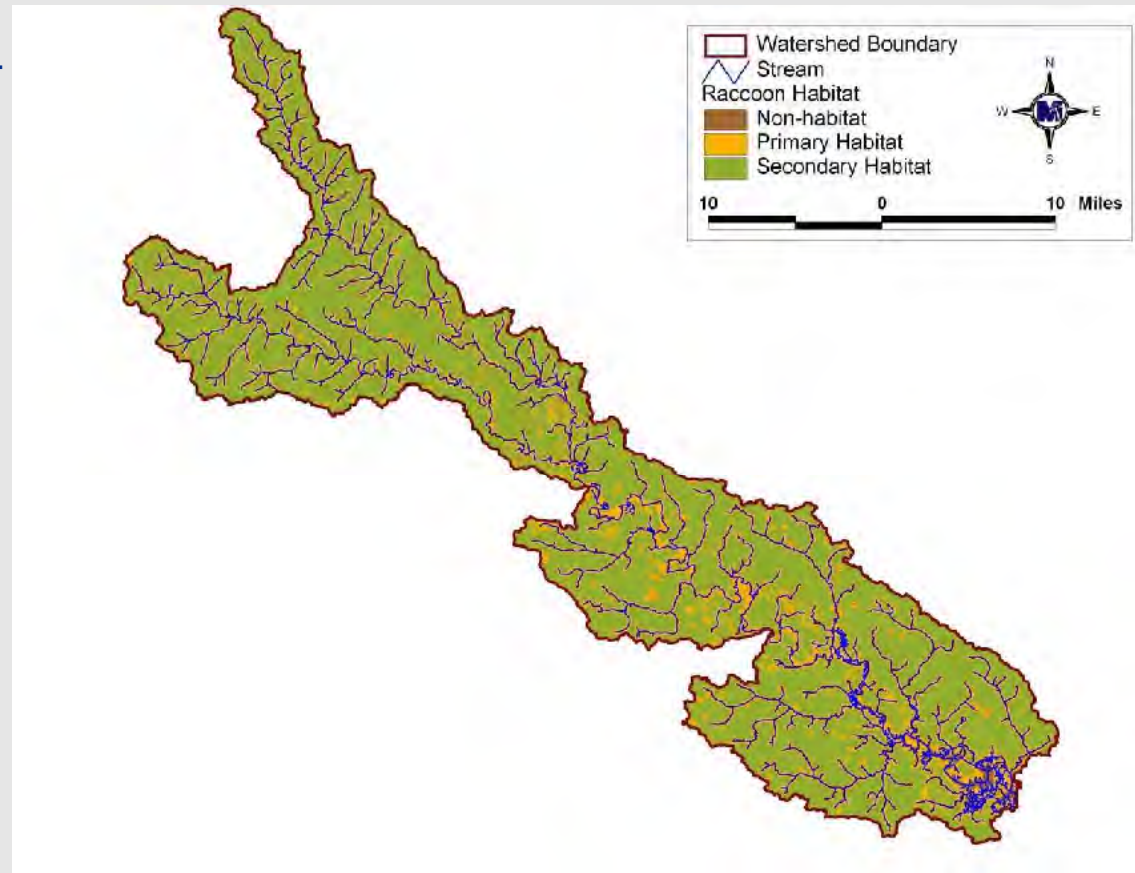
Watershed Area (NTU Segment)	Beef	Beef Calves	Dairy	Dairy Calves	Sheep	Horses
Northeast Creek	354	352	24	12	8	87
North Anna River	504	431	4	2	46	172
Little River	1,005	696	132	64	84	367
Upper Pamunkey River	681	535	172	86	57	305
Middle Pamunkey River	648	546	280	140	36	376
Lower Pamunkey River	73	90	12	6	0	49

Wildlife Sources

- Population
 - Animal densities from VDGIF biologists
 - Habitat from literature values and GIS
- Distribution of waste based on habitat
 - Land-applied
 - Direct deposition to the stream
- Seasonal variations based on migration patterns and food sources

Example: Raccoon density is 0.0343 animal per acre of habitat and there is 188,777 acres of raccoon habitat, raccoon population calculated as:

$$0.0343 * 188,777 = 6,475 \text{ raccoons}$$



Wildlife Source Summary

Watershed Area (NTU Segment)	Raccoon	Muskrat	Duck	Goose	Deer	Turkey	Beaver
Northeast Creek	1,892	1,156	24	12	923	234	44
North Anna River	3,699	2,336	49	24	1,788	447	475
Little River	5,293	3,121	65	32	2,575	655	734
Upper Pamunkey River	5,268	3,075	64	31	2,554	628	739
Middle Pamunkey River	7,231	4,524	94	46	3,526	894	979
Lower Pamunkey River	2,415	2,172	45	22	1,179	298	567

How do we Determine the TMDLs?



+

Watershed data



TMDL

And then:

- Conduct the Analyses
- Public Meeting 2 (Summer)
- Public Review
- Submit to EPA
- State Approval
- Implementation Planning (not contracted yet)





We appreciate that you're taking the time to come to the meeting!
We would also appreciate your feedback!



**Public comment period begins Friday February 22nd, 2013 and ends
Monday March 25th, 2013.**

Comments may be mailed, faxed, or emailed (contact info on next page).

Presentation will be available at the DEQ web site at

<http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLDevelopment/DocumentationforSelectTMDLs.aspx>



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Contact Information

SEND COMMENTS TO:

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Appendix A

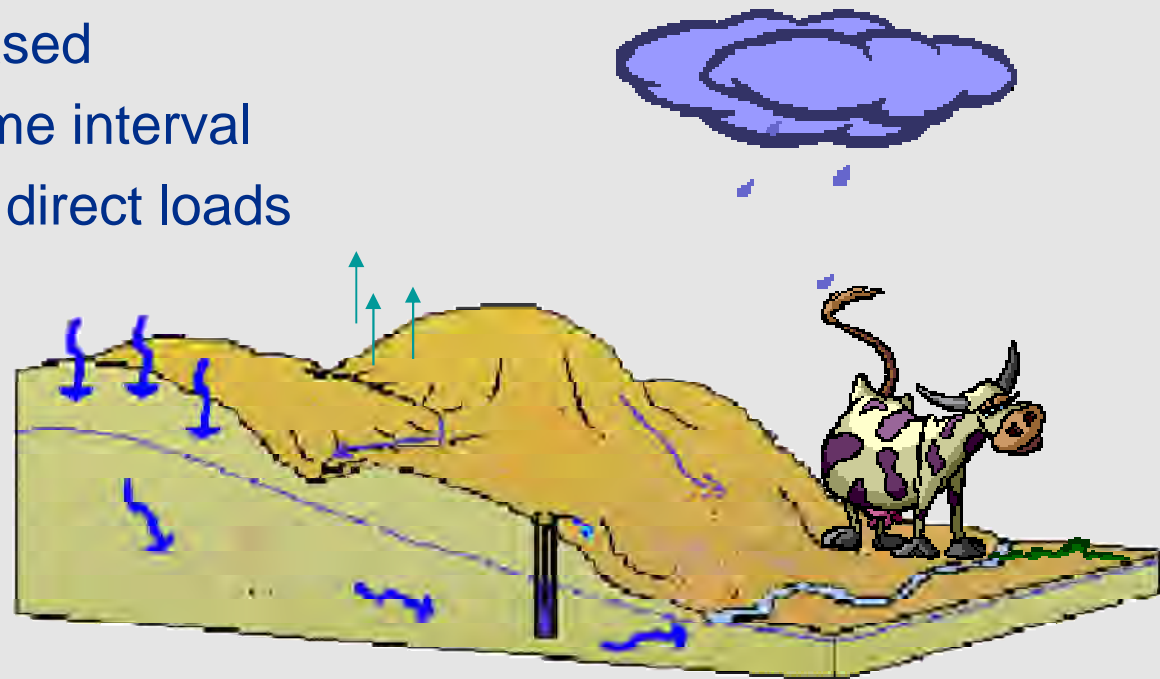
Modeling

Modeling - Bacteria

■ Rainfall-Runoff-Water Quality

■ Hydrologic Simulation Program – Fortran (HSPF)

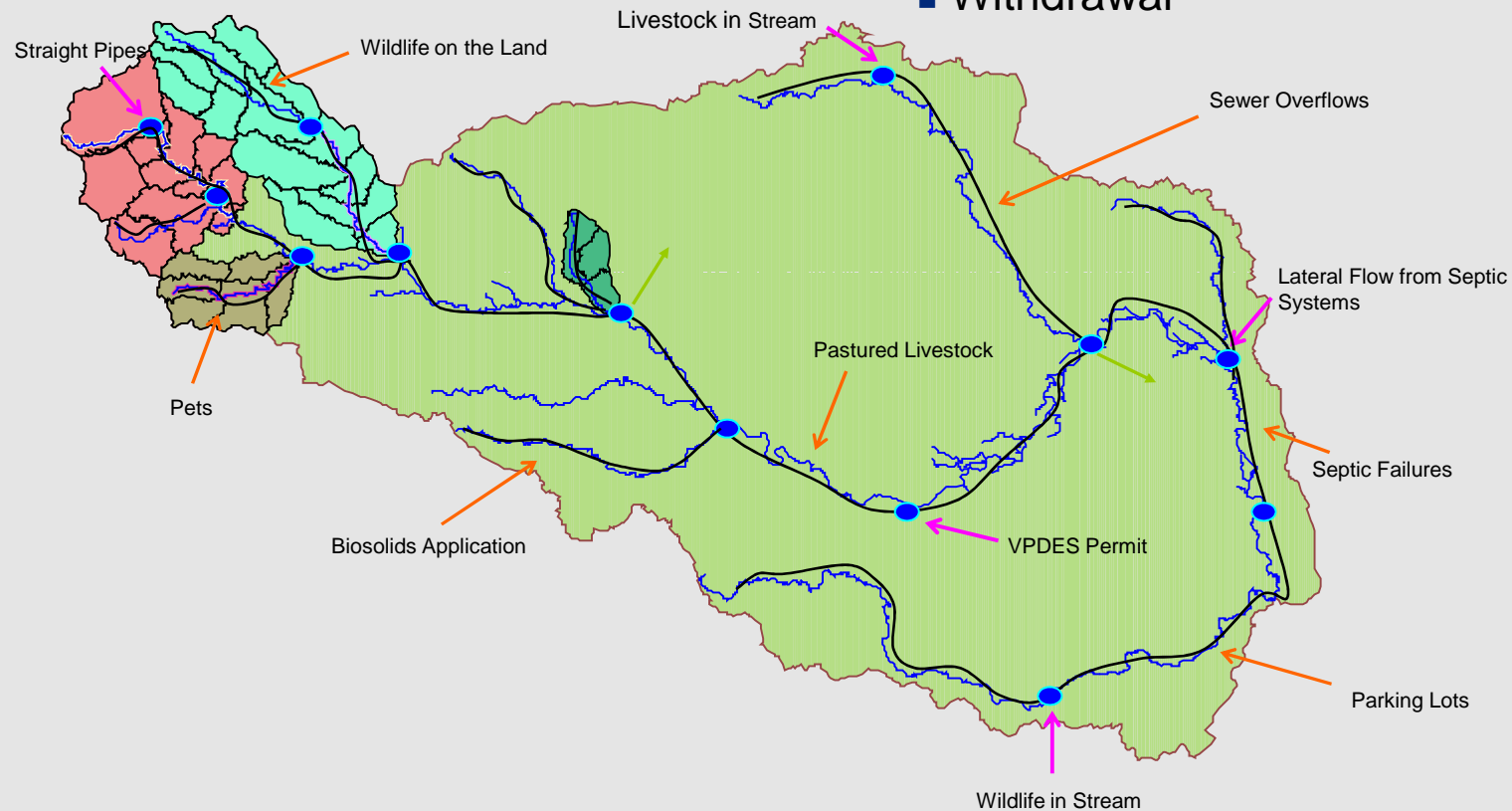
- ◆ Watershed-based
- ◆ Continuous time interval
- ◆ Land-applied, direct loads



Conceptual Model



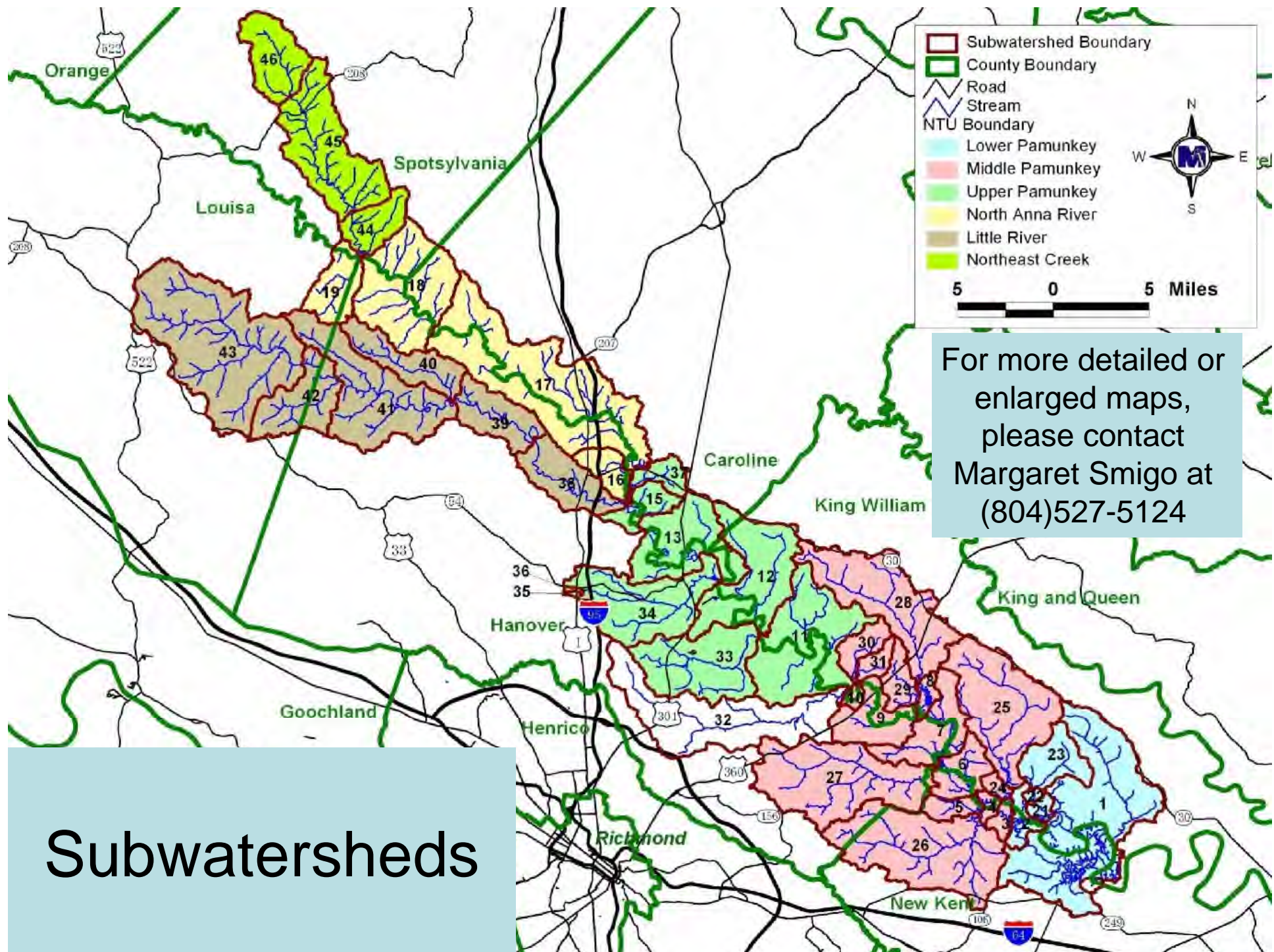
- Mathematical Representation
- Overland
- Direct discharges
- Withdrawal



Appendix B

Source Assessment by Subwatershed

*This information is provided for those
who would like to evaluate the
subwatersheds and provide feedback
on draft estimates*



Human Source

- Population, housing units, and onsite treatment system based on U.S. Census resulting in:
 - HU on sewer, septic, and “other”
- Initial estimates revised based on counties and VDH responses.
- “Other” category is broken down into Privies/Outhouses (90%) and straight pipes (10%)

Human

Sub. ID	Population	HU on Sewer	HU on Septic	HU on Privies / Outhouses	Straight Pipes	Failing Septics	Sub. ID	Population	HU on Sewer	HU on Septic	HU on Privies / Outhouses	Straight Pipes	Failing Septics
1	1,129	3	434	13	1	9	26	3,695	291	1,120	9	1	37
2	34	0	18	1	0	0	27	4,345	36	1,685	14	2	56
3	9	0	4	0	0	0	28	2,588	15	975	33	4	32
4	6	0	3	0	0	0	29	140	1	63	2	0	2
5	113	0	59	1	0	2	30	202	1	76	1	0	3
6	100	0	47	2	0	1	31	121	0	43	1	0	1
7	394	3	158	3	0	4	32	20,285	4,934	2,806	56	6	93
8	24	0	8	0	0	0	33	4,458	170	1,570	53	6	52
9	485	6	187	2	0	6	34	6,502	1,262	903	69	8	30
10	4	0	3	0	0	0	35	966	438	1	0	0	0
11	1,615	7	611	9	1	14	36	631	369	1	1	0	0
12	871	1	200	7	1	4	37	320	7	105	16	2	4
13	525	8	237	18	2	7	38	749	2	295	13	1	10
15	129	18	28	6	1	1	39	473	1	177	3	0	6
16	308	4	125	10	1	4	40	545	12	192	13	1	6
17	2,643	50	973	58	6	32	41	1,501	5	576	29	3	18
18	1,446	46	483	21	2	16	42	816	2	322	19	2	8
19	396	0	165	7	1	3	43	2,639	0	1,036	70	8	21
21	2	0	2	0	0	0	44	531	1	180	7	1	6
22	0	0	0	0	0	0	45	1,688	5	602	18	2	20
23	153	0	57	4	0	2	46	595	0	222	8	1	7
24	8	0	3	0	0	0	Total	65,031	7,699	17,101	612	68	532
25	848	2	346	12	1	12							

Subwatershed 32 is Totopotomoy Creek



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Pet Sources

- Population/household based on literature values, veterinarians, and animal control
- Based on finalized number of housing units by sub-watershed.
- Densities used were:
 - 0.53 dog per housing unit
 - 0.6 cat per housing unit

Pets

Subshed ID	Dogs	Cats	Subshed ID	Dogs	Cats
1	241	270	26	759	850
2	10	11	27	928	1,039
3	2	2	28	547	613
4	2	2	29	35	39
5	32	36	30	42	47
6	26	30	31	24	26
7	87	98	32	4,166	4,666
8	4	5	33	961	1,076
9	105	117	34	1,197	1,341
10	2	2	35	234	263
11	335	376	36	198	222
12	112	125	37	69	78
13	141	158	38	167	187
15	28	32	39	97	109
16	75	84	40	116	130
17	581	651	41	328	367
18	295	330	42	184	206
19	92	103	43	595	666
21	1	2	44	101	113
22	0	0	45	335	375
23	33	37	46	123	138
24	2	2	Total	13,606	15,237
25	193	216			

Subwatershed 32 is Totopotomoy Creek



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Livestock Sources

- Initial estimates of populations are obtained from Virginia Agricultural Statistics and DCR's confined animal operations data.
- The county-wide statistics are broken down into sub-watershed level using the portion of pasture within a subwatershed as compared to the county-wide pasture acreage.
- Estimates were revised (except for horses) based on consultation with SWCD, NRCS, VADCR, and VCE

Livestock

Sub. ID	Beef	Beef Calves	Dairy	dairy calves	Sheep	Horses	Sub. ID	Beef	Beef Calves	Dairy	dairy calves	Sheep	Horses
1	47	57	7	3	0	34	26	42	41	0	0	1	50
2	6	7	1	0	0	5	27	164	134	0	0	14	75
3	3	3	0	0	0	4	28	43	56	9	4	0	22
4	3	3	0	0	0	4	29	16	0	153	77	0	8
5	11	11	0	0	0	15	30	12	15	2	1	0	6
6	39	40	1	0	0	49	31	3	4	1	0	0	2
7	97	36	103	52	7	43	32	176	143	0	0	16	76
8	10	11	1	1	0	5	33	132	107	0	0	12	57
9	149	128	3	2	12	66	34	154	125	0	0	14	67
10	18	15	0	0	2	8	35	0	0	0	0	0	0
11	194	112	162	81	12	88	36	0	0	0	0	0	0
12	80	87	9	5	4	40	37	23	19	0	0	5	9
13	69	61	1	0	8	30	38	42	34	0	0	4	18
15	30	24	0	0	4	13	39	71	58	0	0	6	31
16	47	38	0	0	5	20	40	175	142	0	0	16	75
17	173	140	0	0	21	74	41	304	170	132	64	28	135
18	223	203	4	2	16	63	42	120	97	0	0	10	44
19	61	49	0	0	4	15	43	293	196	0	0	20	64
21	10	14	2	1	0	5	44	111	123	7	3	2	23
22	4	6	1	0	0	2	45	190	170	14	7	5	52
23	5	6	1	0	0	2	46	54	59	3	2	1	11
24	0	0	0	0	0	0	Total	3,440	2,793	624	310	247	1,431
25	38	50	8	4	0	20							

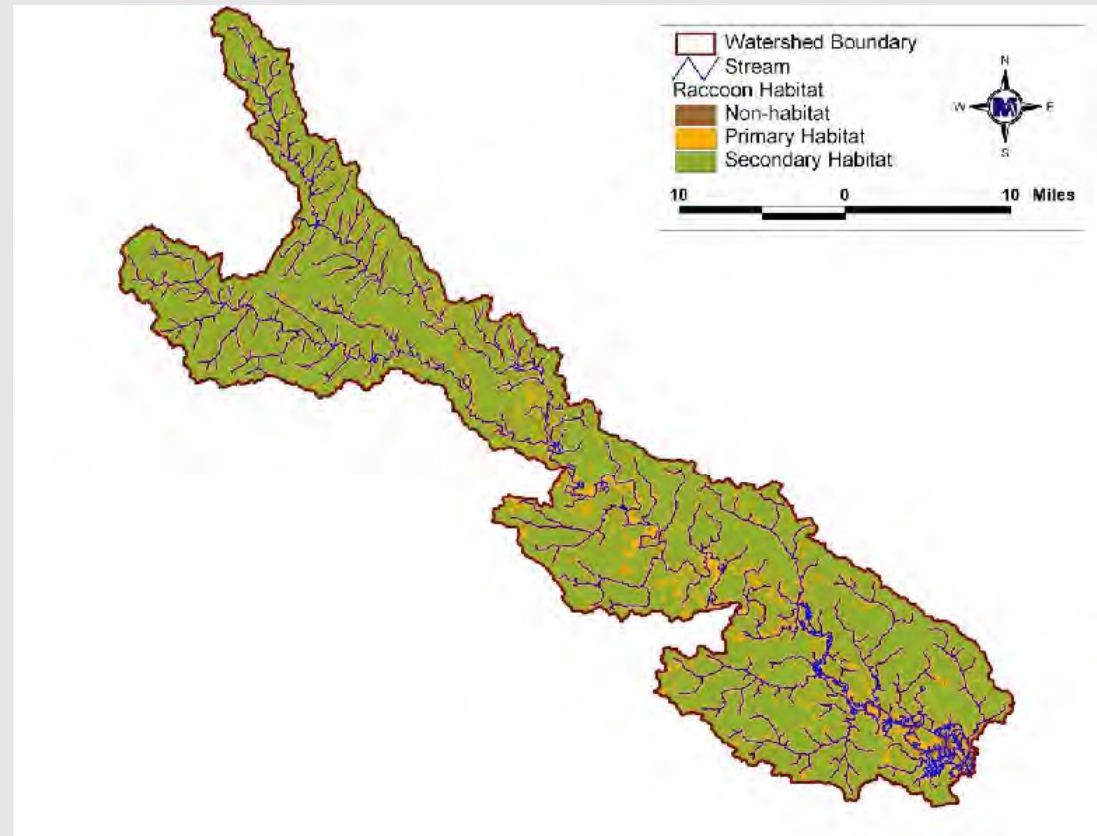
Subwatershed 32 is Totopotomoy Creek



NATURAL RESOURCE SOLUTIONS
THROUGH *Science AND Engineering*

Wildlife Sources

- Population
 - Animal densities from VDGIF biologists
 - Habitat from literature values and GIS
- Distribution of waste based on habitat
 - Land-applied
 - Direct deposition to the stream
- Seasonal variations based on migration patterns and food sources
- Example: If raccoon density were 0.0343 animal per acre of habitat, and there were 188,777 acres of raccoon habitat, then raccoon population would be $0.0343 * 188,777 = 6,475$ raccoon.



Wildlife

Sub ID	Raccoon	Muskrat	Duck	Goose	Deer	Turkey	Beaver	Sub ID	Raccoon	Muskrat	Duck	Goose	Deer	Turkey	Beaver
1	1,839	1,715	64	32	898	227	462	26	1,424	811	17	8	695	177	166
2	130	175	6	3	63	16	50	27	1,312	697	15	7	640	161	135
3	74	82	8	1	36	9	19	28	1,099	608	16	8	531	132	114
4	56	107	3	1	27	7	27	29	202	138	4	2	99	25	28
5	139	138	5	2	68	17	31	30	201	96	2	1	98	25	21
6	291	279	11	5	142	37	70	31	110	50	1	1	54	14	10
7	499	407	13	6	244	63	105	32	1,369	617	13	6	654	139	123
8	82	135	6	3	40	10	44	33	902	477	10	5	438	103	94
9	453	257	8	4	222	57	54	34	954	518	11	5	454	106	107
10	49	49	2	1	24	6	10	35	10	1	0	0	4	0	25
11	1,205	702	26	13	589	149	142	36	10	0	0	0	3	0	57
12	971	516	22	11	474	122	105	37	176	125	3	1	86	20	54
13	805	554	16	8	392	99	113	38	515	275	6	3	250	61	58
15	235	182	4	2	115	29	42	39	456	291	6	3	218	57	151
16	221	109	2	1	97	20	23	40	480	285	6	3	233	60	70
17	1,973	1,236	26	13	956	239	248	41	1,189	742	15	10	581	148	248
18	1,127	751	16	8	550	140	155	42	581	336	7	6	283	72	50
19	379	239	5	4	185	48	49	43	2,072	1,191	25	15	1,010	258	158
21	62	78	2	1	30	8	19	44	332	232	5	2	162	42	44
22	29	25	1	0	14	4	5	45	1,053	718	15	7	513	130	0
23	354	179	5	2	173	44	31	46	508	206	4	2	248	62	0
24	64	57	1	1	31	8	12	Total	27,168	17,001	449	225	13,198	3,297	3,661
25	1,176	615	16	8	574	146	132								

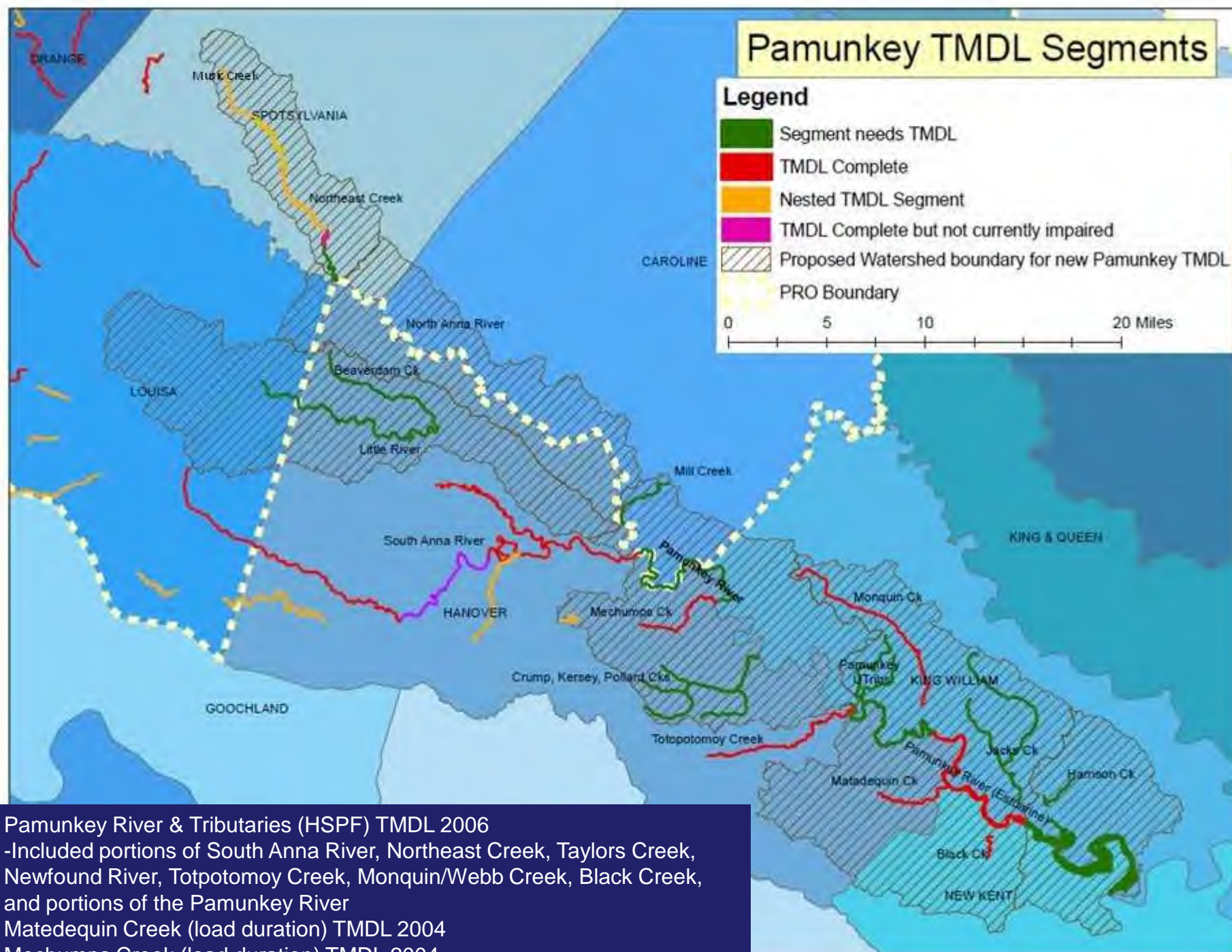
Subwatershed 32 is Totopotomoy Creek



NATURAL RESOURCE SOLUTIONS
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Appendix C

Map Summary of Impairments Included in Current TMDL study,
Completed TMDL studies, in Addition to Nested Impairments



Pamunkey River & Tributaries (HSPF) TMDL 2006
 -Included portions of South Anna River, Northeast Creek, Taylors Creek, Newfound River, Totopotomoy Creek, Monquin/Webb Creek, Black Creek, and portions of the Pamunkey River
 Matedequin Creek (load duration) TMDL 2004
 Mechumps Creek (load duration) TMDL 2004